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Downy Mildew

A Serious Disease of Grape Vines in Mysore

BY

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The downy mildew of the grape vine is one of the best known plant diseases in Europe and America. It is supposed to be a native of North America. It was noticed in the United States of America in 1834, and spread to Europe in 1878. The insect, Phylloxera, was doing great damage to the vines in France, and in order to control it the French imported some resistant American grape stock, and in doing so unknowingly and to their great cost, introduced the downy mildew. This is an instance of a disease which has taken a heavier toll in the country of its introduction than in its native country, owing to the upsetting of the equilibrium between the host and parasite. The disease did not spread to South Africa till 1907 and it was only so late as 1917 that it was introduced into Australia from Europe. As for India, it was found in Poona in 1910 and in Madras about the year 1920, and mention has also been made of its occurrence in Mandalay, Burma. In Mysore the disease was first noticed in October 1931 at Bangalore, and a little later in the same year at Kolar. In 1932 it was noticed in a number of vineyards in Bangalore and all evidence goes to indicate that the disease

is spreading fast. It is only a question of time when it will assume the nature of an epidemic.

The downy mildew makes its appearance during the rains of the north-east monsoon. It attacks all green parts of the plant, *viz.*, leaves, petioles, tendrils, green shoots and fruits. The first symptom on the leaves is the appearance upon the upper surface of pale yellow spots of variable size and form, which appear transparent when the leaves are held up to the light. These are designated "oil-spots" by the French. Under moist warm conditions, the under-surfaces of the leaves immediately opposite these spots are covered by a white glistening growth which is quite unmistakable. (Fig. 1.) It is this growth that has given the disease the name "downy mildew", and it is this that serves to distinguish this disease from another common mildew of the grapes called the powdery mildew which forms grayish white patches on both the surfaces of the leaves. As the spots grow older the leaf tissues are slowly killed, the colour changing from yellow to brown. In very advanced cases the spots run together involving almost the whole leaf or a major portion of it. The green shoots, leaf-stalks and tendrils are also affected. In advanced cases the young shoots may become dwarfed or deformed and the leaves remain small. (Fig. 2.) In very serious cases the shoots may die. When leaf-stalks are affected, the leaves shed. Affected fruits shrivel and become hardened.

The downy mildew is caused by a fungus called *Plasmopara viticola* (B & C) Berl. & De T. This fungus belongs to the same family as that to which the fungus causing areca *koleroga* belongs. It is able to spread rapidly in wet weather and is retarded in its development by dry weather. The fungus is able to tide over the dry months by the aid of resting-spores or oospores which are formed in the tissues of the leaf.

The losses due to this disease are difficult to be estimated properly, as it often occurs along with another equally serious disease, rust. The loss due to the downy mildew has ranged from 25-75 per cent of the crop in America. Luckily both these diseases can be kept in check if proper precautionary measures are taken in time.

There are two means of controlling the downy mildew. All old and fallen leaves and debris should be ploughed under or, better

Fig. 1.—View of the underside of a grapevine leaf attacked by downy mildew.

Fig. 2.—Downy mildew on the shoots and tendrils, showing dwarfing and deformation.

still, burnt since they harbour the resting stage of the fungus. The next step is to prevent the fungus from developing on the leaves and other portions of the plant, since once it is established it is difficult to save the crop. This is done by spraying with one per cent Bordeaux mixture with casein adhesive. Three or more sprayings may be necessary and they should be undertaken just in advance of anticipated rainy periods. The first spraying may be given when the shoots are 6 to 8 inches long, the second just after blossoming and the third before the fruit changes colour. Preliminary experiments conducted by the Department at Bangalore showed that the disease could be kept in check by spraying. In a vineyard of fair-sized plants the average cost of chemicals and labour per plant per spraying would not exceed three-fourths to one anna. The first spraying after pruning may cost very much less than this.

Some doubts might be expressed by unknowing people as to the safety in consuming sprayed grapes. There need be no anxiety on this point. Analyses conducted elsewhere have shown that an adult may eat from 300-500 lbs. of sprayed grapes per day without fear of ill-effects from the copper.

To the mycologist and the practical gardener the downy mildew and Bordeaux mixture have peculiar associations, on account of the discovery of the treatment by the great French plant pathologist, Millardet. It was the practice in vineyards adjacent to the public highways to sprinkle a few rows of vines with a mixture of bluestone (Copper sulphate) and lime to give them a poisonous appearance and thus prevent pilfering of the grapes. It was found that the rows so treated were comparatively free from mildew. Millardet ascribed the beneficial effects to the lime-bluestone mixture and after a series of careful experiments in the years 1883 and 1884 drew up in the next year his directions for preparing Bordeaux mixture.

Table Showing the Proportion of Ingredients in Bordeaux Mixture.

	Millardet's prescription.	Against Areca *Koleroga*.	Against Coffee *Koleroga*.
Water ..	130 litres	150 litres	150 litres
Bluestone ..	8 kilograms	3 kilograms	1½ to ¾ kg.
Lime ..	15 ,,	3 ,,	1½ to ¾ ,,

The mixture was to be shaken upon the plants with a broom. Since then, the mixture and the methods of application have undergone very great changes. In Mysore the pneumatic one-gallon sprayer is a household utensil in the Shimoga and Kadur *malnad*, and the D.S.P. headland pump and the power sprayer are in use in some of the bigger coffee estates. It can be seen by a reference to the above table that the Bordeaux mixture now in use against areca *koleroga* contains only about a third of bluestone and a sixth of lime of the Millardet mixture, while that used against coffee *koleroga* contains only half and sometimes a quarter of what is used against areca *koleroga*. The strength of the mixture used against coffee *koleroga* is what is now recommended for spraying against downy mildew of grapes.

Cultivation of Virginia Tobacco in Whitefield

BY

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Introduction.

In the course of conversation among some friends in my village of Kadgodi adjoining the Whitefield Railway Station, someone asked whether the Peninsular Tobacco Company would purchase tobacco from us in case we grew the particular kind of tobacco used by them for making cigarettes, the seed being supplied by them. I undertook to write and find out what they wanted. The Peninsular Tobacco Company, on reference, advised the Indian Leaf Tobacco Development Company, Limited, Calcutta, to put themselves in correspondence with me, and, as the result of it, I was informed that a Director of the company would come to Whitefield to meet the prospective growers and discuss matters. Early in April 1927 the meeting took place and the arrangement that was agreed to between the raiyats and the company was as follows. The required quantity of seeds was to be sent to us by the company, the nursery, the planting, cultivation, etc., being attended to by us according to instructions to be sent to us in writing. At about the time when leaves are ready for picking, the company was to send us one of their workers to help us in curing the leaves on racks under sheds. Everything was done by us according to instructions and, in the

latter part of the year, a man was also sent by the company. With his help, the leaves were cured and intimation was sent to Calcutta that arrangements might be made to inspect and purchase the tobacco. Under advice from the I.L.T.D. Co., one of the officers of the Peninsular Tobacco Co., Bangalore, purchased the tobacco at 6 annas per pound. The quality of tobacco being found suitable by the manufacturers, a staff of officers and clerks was posted to this place to begin experimental cultivation on a large scale. This arrangement has been working here since 1928. At first the growers were asked to dry the leaves themselves, but, owing to the fact that it involved some expense in erecting sheds and also interfered with the ragi harvest and thrashing, the arrangement became unpopular, although the grower stood to benefit more if he did the entire curing. However, for two years, the raiyat dried a part of his output and sold the other part as green leaves which the company dried in their sheds for demonstration purposes. Later on, as the result of their success in the Guntur district in the flue-curing of tobacco, the company constructed some barns here also. All the leaves are now purchased in the green state and cured in the company's barns. Until the middle of the year 1932 there was no competition of any sort and the grower was not satisfied that he got what was due to him even according to an one-sided agreement entered into with the company. As however, he got some ready cash to defray his expenses for ragi harvesting and thrashing and to meet the government dues, the raiyat had been growing tobacco, although getting underpaid, in the hope that competition was to come in the near future and make tobacco growing a paying proposition. As anticipated, a new Indian company by name "The Hyderabad Deccan Tobacco Factory" have entered the field this year and have been purchasing green tobacco and curing them in the barns which they have recently built at Varthur.

The area now under tobacco is 300 acres. It will be at least double this next year.

Varieties, Soils, Etc.

Adcock was the variety which was in cultivation to begin with. Now Harrisons Special is the variety under cultivation. Light sandy soils produce good quality.

Nursery.

Seedbeds are prepared and nursery raised at about the time we begin planting potatoes, *viz.*, Bharani rain in the middle of May, and subsequently. As tobacco seedlings are very susceptible to wet-rot, drainage has to be amply provided for. The seeds are sown in the same way as in the case of country tobacco and watering is done five or six times a day.

Transplanting.

After the seedlings attain a height of three to four inches which will be in about 6 to 8 weeks, they are transplanted three feet apart in the dry fields which have been ploughed, manured and kept ready. This work is generally done after a rainy day and should there be rain on the day of transplantation, it would be a great advantage. Otherwise the plants should be watered, for a few days, until they are established, that is, until they raise their heads.

Cultivation.

In the intervals of rains, it would be useful to intercultivate. Weeding should be done as often as is necessary. Whether topping should be done, if so when and at what height, depends upon circumstances, bearing always in mind that what is required is a medium-bodied light green leaf and not a thick dark leaf. Suckers should be pinched when they appear. Leaves fit for curing will be available in about $2\frac{1}{2}$ to 3 months. These are bought by the company at 8 pies per pound.

Curing.

Sun-drying is a laborious process and may be ruled out in these days when flue-curing has become an easy matter and not a very costly affair too. Apart from the very superior quality obtainable by the latter process, the operation is over in about 95 to 120 hours, whereas the former method would take about a month and, if the weather conditions too are unfavourable with very low humidity, the leaf may not be soft and ready for baling for weeks on end.

"In flue-curing, the tobacco is hung on racks in a barn which is supplied with an artificial source of heat and fitted with ventilators; conditions of temperature and humidity are therefore under strict control and can be varied to suit the conditions of leaf."

Barns.

A pucca barn 20′ x 20′ x 20′ with two furnaces, flue-pipes, one door, a dozen ventilators, corrugated galvanized iron-sheet roof, can be constructed for about Rs. 2,000. One barn can deal with the produce of about 25 acres of tobacco in 10 curings of about four to five days each. A barn can take 4,500 lbs. of green tobacco at each curing representing the produce from two and a half acres in the present state of cultivation.

Cost of Curing.

Approximate cost of curing 4,500 lbs. of green tobacco and grading them is indicated below for the benefit of those who wish to take up curing as a profession.

	Rs.	A.	P.
Rent of barn (including interest on capital, depreciation, building fund, etc.)	30	0	0
Proportional cost of bamboos	2	8	0
,, ,, twine	1	8	0
,, ,, stands	2	0	0
,, ,, trays	0	8	0
Wages of firemen	5	8	0
,, labourers	14	0	0
,, clerks on day and night supervision duty ..	10	0	0
Cost of $1\frac{1}{4}$ ton coal	27	8	0
Grading	6	8	0
	100	0	0
Cost of 4,500 lbs. of green tobacco @ 8 pies per lb. ..	187	8	0
Cost of 855 lbs. (19% on 4,500) of cured tobacco ..	287	8	0

The above 855 lbs. will be of different grades and the proportion and prices that may be expected are indicated below. The prices are those now offered by the I.L.T.D. Co., Ltd., Whitefield branch.

	Rs.	A.	P.
First Grade 30% or 256.5 lbs. @ 9 as. per lb. ..	144	4	6
Second ,, 30% or 256.5 lbs. @ 7 as. per lb. ..	112	3	6
Third ,, 20% or 171.0 lbs. @ 5 as. per lb. ..	53	7	0
Fourth ,, 10% or 85.5 lbs. @ 3 as. per lb. ..	16	0	0
Fifth ,, 10% or 85.5 lbs. @ 1 an. per lb. ..	5	5	6
	331	4	6

or say Rs. 331 0 0

Profit on one curing=(Rs. 331-0-0 *minus* Rs. 287-8-0) or
Rs. 43-8-0

=Rs. 43—8—0

The company has demonstrated to the raiyats these 5 years the cultivation and curing of tobacco, and their policy for the future is to let the people grow and cure the tobacco themselves, the company simply buying the tobacco offered for sale. The raiyat is still not in a position to find the money to construct barns and this is an opportunity for people with some capital to invest in the construction of barns and do the curing for profit. The curing and grading will be completed in a week and payment is made to the curer immediately afterwards. The raiyat can thus be paid for his green leaf within a fortnight after the green leaf is purchased even if the curer has not enough liquid cash to pay the raiyat at once. In any case, one who proposes to take up curing must have at least Rs. 1,000 in cash for each barn after the barn is constructed. The more intelligently the work is done the greater will be the profit. Here is scope for agriculturally trained young men to find a decent means of living. If they cannot construct barns they can hire one of the company's barns to start with. The officers of the company are very eager to teach people to cure tobacco.

Future of Tobacco.

The raiyat of this place stumbled upon a money crop by accident. Only a beginning has been made and the future seems full of possibilities. At the present state of cultivation, our average production is only about 1,750 lbs. of green leaves which is equivalent to 350 lbs. of cured leaves per acre. The average production per acre in the Guntur district of the Madras Presidency, where 25,000 acres are under this crop, is $2\frac{1}{2}$ times of that found possible in and around Whitefield. In Behar also the average production is as high as in Guntur. In the Southern States of America the production is nearly 1,000 lbs. per acre. If for the same trouble in cultivation and perhaps a little more expense in fertilizing, the local average production could be increased the raiyat should be very grateful indeed. The purchasing companies remain content at this stage because, as the area under cultivation is increasing rapidly, it matters

little to them if a certain quantity of tobacco is obtained from one acre or four acres. The companies do not seem to be in any hurry, towards making experiments to increase production. The raiyat, however, cannot rest content. Cigarette making concerns are importing several million pounds of American tobacco paying a very high import duty of Rs. 1–8–0 per pound, as only an infinitesimal quantity of the demand is met from this country. The quality now available at this place is not much inferior to the American tobacco. Improvement in quality is only a matter of skill and experience, and this province of Mysore at least, is not lacking in men of high scientific attainments. In any case, there is considerable demand for tobacco of the quality at present attained. Also there is no fear that smoking will decrease in spite of economic depression. It is a matter of urgency that the cultivation and curing of cigarette tobacco should be brought to a high level while the high import duty is operating and the *swadeshi* spirit is pervading the country. It devolves upon the Department of Agriculture to come to the aid of the raiyat without loss of time, especially as the prices for his other crops are very low.

Groundnut

Its Products, Composition and Uses

BY

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Groundnut is a legume and every part of the plant is useful. The green plant is relished by farm stock and the hay is very nutritious. The fruit which ripens underground has an outer shell, an inner husk and two cotyledons rich in nitrogen and oil. The size of nut and the thickness and proportion of shell vary with different varieties. Bigger nuts occupy more volume than smaller and heavier ones. Unfortunately in many countries the seeds are sold by measure and not by weight; consequently there is a tendency for the farmers to grow big-podded varieties in preference to the others which are richer in oils. To encourage the cultivation of oil yielding varieties a universal adoption of rating the value of the nuts on a basis of oil content and the percentage of decorticated to unshelled nuts is highly desirable.

Chemical Composition of the Plant.

The whole plant is rich in nitrogen, sugars and non-sugars. Most of the oil is found in the seeds. The following is the analysis of various parts of the plant :—

	Nitrogen	Phosphoric acid	Oil	Sugars	Non-sugars
	%	%	%	%	%
Stem ..	9.8	0.33	1.4	20.7	58.4
Leaves ..	11.81	0.32	3.4	17.5	38.6
Fruit stocks ..	7.45	0.22	1.1	21.7	54.7

The pericarp or shell which forms nearly 25 to 30 per cent of the weight of pods contains some appreciable quantity of potash and nearly twice as much nitrogen as is present in ordinary farm-yard manure. It is poor in phosphoric acid. The softer portion of the shell is sometimes added to the oil-cake to increase the bulk. The seed-coat is very similar to the shell in composition.

	Nitrogen	Phosphoric acid	Potash
	%	%	%
Pericarp or shell	1.55	0.287	0.672
Episperm or seed coat ..	1.78	0.19	0.514

The stem of the plant is very rich in salts and contains 2.08 per cent of lime. Excepting the shell, the other parts—kernel and stem—are fairly rich in potash and nitrogen.

	Nitrogen	Potash	Phosphoric acid	Lime	Total ash
	%	%	%	%	%
Stem without leaf..	4.5	1.27	1.24	2.03	15.70
Kernel	4.5	1.27	1.24	0.13	3.20
Shell	1.1	0.95	0.17	0.81	3.00
Cake powder ..	7.56	1.50	1.31	0.16	3.97

The kernel contains over half the weight of oil and it is rich in proteids and non-nitrogenous materials. The following table gives the composition of a typical sample from Senegal :—

	Per cent
Moisture	6.76
Oil	51.75
Proteids	21.80=3.43% nitrogen
Non-nitrogenous material ..	17.66
Phosphoric acid	0.64
Potassium chloride and magnesia	1.39

There is more protein in the stem than in leaves or roots. It contains more fat and the largest quantity of salts. The roots are richer in nitrogen-free extract than the other parts. As the vines ripen the plant becomes more fibrous, loses much of its fat and accumulates more of salts.

An analysis of the ash of the whole plant shows that it contains the following salts :—

Sulphates of Potash	0.33
Chloride of Sodium	1.80
Lime as CaO	3.75
Magnesium as MgO	4.92
Partly soluble Phosphoric acid ..	1.02
Insoluble	3.03
Total Potash as K_2O	12.45
Silica, alumina, sand, iron, etc. ..	72.70
	100.00

The total phosphoric acid is 4.05 or equivalent to phosphate of lime 8.83 per cent.

	Fibre.	Protein.	Nitrogen-free extract.	Fat.	Nitrogen.	Ash.
	%	%	%	%	%	%
Leaves	32.95	6.25	49.49	2.50	1.0	8.8
Stem..	21.51	10.00	34.09	3.5	1.6	10.9
Roots	23.50	8.75	59.10	2.00	1.4	6.6
Stem with leaves before the pods were ripe ..	22.32	12.63	48.34	6.07	2.02	10.64
Stem cut when the pods were ripe	32.28	10.81	38.81	5.02	1.73	12.08
Straw and leaf gathered in the field	22.11	11.75	46.95	1.84	1.88	17.04

The cotyledons and the germ are very similar in composition with this difference that there is a little more of salts and oil in the germ than in the cotyledons.

	Protein.	Nitrogen-free extract.	Fat.	Ash.
Germs.. ..	29.1	12.0	45.4	3.1
Cotyledons ..	29.8	12.9	47.2	2.4

Groundnuts are rich in proteins and oils.

Proteins of groundnut are found as basic nitrogen in the globulins, arachin and conarachin (*J. Biol. Chem.*, 1917-30, 33-38).

C. O. Johns and D. Breese Jones (*J. Biol. Chem.* 1917-30, 33-38) have shown that the proteins in groundnut are high in the amino acid, lysine. Osborne and Mendel and other workers have shown that lysine is essential to the growth of animals. Nutrition experiments indicate that the animal organism cannot synthesise lysine, which must, therefore, be provided in suitable quantity in the food to insure normal growth. Since the muscle substance of animals contains about 7 per cent of lysine, foods deficient in this essential amino acid should be supplemented by the addition of other foods which contain a high percentage of it. Wheat and corn, both of which contain but little lysine should therefore prove more efficient diets if supplemented by food of high lysine content. Peanut meal appears to be well adapted to this purpose. From a nutritive standpoint, it is one of our chiefest foods and seems to possess no objectionable properties. It therefore seems probable that corn and wheat could be much better utilized and a considerable saving in the cost of feeding effected by supplementing these cereals with peanut meal.

Meals containing 45 to 50 per cent of protein are produced but seldom placed on the market. Sometimes meals containing all hulls and the mixture having 34 to 38 per cent protein are produced. Generally there are many grades, from pure meal to mixtures having different amounts of powdered hulls.

Oil.

Groundnut oil is a non-drying oil, like olive, almond and peach-stone oils. It becomes turbid at + 8°C. hardens at + 6°C. and becomes quite solid at −3°C.

Density of oil at	+15°C.	is 0.918
,,	+20°C.	,, 0.916
,,	+26°C.	,, 0.913
,,	+28°C.	,, 0.911
,,	+30°C.	,, 0.918

The quality and specific gravity of the oil are as follows :—

Specific gravity at 15.5°C. ..	= 0.925	
Saponification value ..	=185.6	to 197
Iodine value per cent ..	= 84.6	to 105
Reichart-musal value ..	= 0.0	to 1.6
Hehner value	= 94.8	to 95.8
Titer test 0°C.	= 28.1	to 29.2

Chemical composition :—Groundnut oil consists of four glycerides of four different fatty acids :—

1. Oleic acid $C_{18}H_{34}O_2$ is the chief constituent.

2. Hypogæic acid $C_{16}H_{30}O_2$ was pointed out in 1854 by Gossman and Scheven as a new acid. Both chemists think that it agrees with one of the fatty acids obtained from whale. The melting point is between 34° and 35°C.

3. Palmitic acid $C_{20}H_{40}O_2$.

4. The fourth acid is similar to the one which is generally met with in the fatty acids of butter and olive oil. Oudemans in 1866 found it in the tallow of *Nephilium lappaceum* L., an Indian plant of the order *Sapendaceæ*. Treated with hyponitric acid which may be most conveniently obtained by heating nitric acid with a little starch, a solid mass is obtained which yields by crystallization from Alcohol Elaided and gacidinic acids, the former is isomeric with oleic and the latter with hypogæic acid (*Pharm.*, by Fluck and Haub. p. 187).

Groundnut usually contains 70-75 per cent seed and 30-25 per cent shell. But the oil content varies slightly with soil and climatic conditions. There are a few varieties like Spanish and small Japan having nearly 50 per cent of oil. On an average 48 per cent can be taken as the oil content of a good sample. Of this 30-35 per cent can be pressed out by cold pressing and 8-12 per cent more after applying some heat. Second pressing yields a low grade oil.

Good oil "is limpid, of a light colour,—faint musty odour—and bland taste." Oils are now made at Marseilles, Bordeaux and Delft from West African and Indian nuts. Large quantities are now refined from low grades and made fit for edible purposes.

As a burning oil it is good. It burns for a long period but the flame is not very bright.

Good qualities of oil are expressed from Senegal and Gambia. The oil is used as a substitute for olive oil and for blending with olive oil of a harsh taste. It is commonly used as a salad oil. A large quantity is used in the manufacture of margarine. For soap boiling oil is extracted by the help of chemicals like carbon-bisulphide, petroleum ether, benzene or canadol. The cake derived in such process is unfit for feeding purposes. Groundnut oil is used specially for making white Marseilles soap. It is non-drying and may be used as a lubricant. It is a good medium for wool oiling and for other industrial purposes. It is used occasionally as an illuminant, and as a curry oil and for preserving sardines. The following table gives the burning capacity of groundnut in comparison with other oils.

Fifty grams of oil were taken in each case.	Number of burning hours.
Olive oil ..	10 hrs. 29 min.
Colza oil ..	11 hrs. 18 min.
Sesame oil ..	11 hrs. 33 min.
Groundnut oil ..	12 hrs. 29 min.

It is used as a substitute for olive oil in Br. Pharmacopœia for use in India, Eastern Africa and Australia.

Groundnut oil is mostly used in the manufacture of margarine which is essentially a mixture of fats and oils blended with water, milk and salt. Fats used are either animal or vegetable and oils are of vegetable origin.

Margarine consists of :—

Animal fat ..	25%
Vegetable fat ..	35%
(Cocoanut and palm kernel)	
Vegetable oils ..	26%
Water, milk and salt ..	14%

Vegetable fats are now preferred to animal fats. They are harder and take in more oil.

Artificially hardened fats are now being used in the manufacture of margarine. By hydrogenation processes fish and linseed oil can be hardened to any desired degree. As it is, groundnut oil has a good demand and is not hardened. It is a high class oil for blending. Total consumption of oil in N. Europe for manufacturing margarine in 1923 was 150,000 metric tons or 599,500 barrels. Out of the 150,000 tons of oils used, other oils amounted to 41,000 tons. There was competition for 109,000 tons between cotton seed oil and groundnut oil. The amount of cotton seed oil consumed was 49,000 tons. Groundnut oil has become a serious rival to cotton seed oil though there is not a sufficient quantity of it.

Rape and Sesame compete with groundnut oil. Sesame is costly. It is a good salad oil and is easily tested by the simple chemical test (Baudouin reaction) and therefore it serves as a ready method of distinguishing margarine from butter. It is legally required in some countries to add sesame oil as a component of margarine so that the margarine may be easily distinguished from real butter. Quantities of sesame available are small and therefore it is no serious rival to groundnut.

The feeding value of groundnut hay is very high. It is slightly poorer in fat and proteins than Lucerne or clover hay. It contains less moisture and less fibre and very much more of ash than the others. In India the cultivators consider that groundnut hay or straw is too rich a food for feeding stock. If the animals happen to eat large quantities of green plants they begin to purge badly. It is therefore always given along with the straws of millets or paddy.

The following two tables give the composition of various kinds of hays and a few of the feeding stuffs that are now usually made use of on the farms in Europe and America :—

Fat, Protein and Hydro-carbon contents of groundnut hay compared with other fodders and feeds.

	Protein.	Hydro-carbons.	Fat.
Groundnut hay ..	11.75	46.95	1.84
,, entire plants ..	13.48	36.28	15.06
	13.5	36.2	15.0
,, stems only ..	10.0	42.0	3.6
,, kernel ..	26.6	16.7	42.0
Clover hay ..	12.84	48.31	2.11
	12.4	33.8	4.5
Lucerne hay ..	16.48	42.62	2.03
	14.3	42.7	2.2
Cowpea ..	19.72	45.15	4.04
Ground maize and oats ..	9.6	71.9	4.4
Maize flour ..	9.2	68.7	3.8
Wheat flour ..	15.4	60.4	4.0
Cotton seed cake ..	42.3	23.6	13.1

	Groundnut hay.	Clover hay.	Lucerne hay.
Moisture ..	7.83	14.30	6.95
Nitrogen ..	11.75	12.84	16.48
Fat ..	1.84	2.11	2.03
Carbohydrates ..	46.95	48.31	42.62
Fibre ..	22.11	29.27	31.38
Ash ..	17.04	7.47	7.49

Groundnut Cake.

Groundnut cake contains a higher percentage of protein and oil in combination than any other cake. Moreover these proteins are easily digestible. The cake is in great demand in Germany for feeding stock and it is also considered a valuable cattle food in Denmark and Sweden. Cakes of inferior quality are generally used as manure especially in intensive market gardening in France. In England the British farmer still prefers linseed and cotton seed cakes. Very high grade oil-cakes are secured from nuts imported from Senegal. These nuts are imported as unshelled nuts and pressed in France, Germany and Holland. They yield an almost white

cake like that of cocoanut cake in appearance. Generally the colour depends upon the colour of the seed coat.

At Bordeaux the seed coat is mostly removed and the cake produced there contains 62 per cent of protein and oil.

According to Kellner's starch equivalent value groundnut cake is as good as that of cocoanut, linseed or cotton.

	Starch Equivalent.
Groundnut (Senegal) ..	77.5
Cotton seed decorticated ..	72.3
Linseed extracted ..	71.8
Palm kernel pressed ..	78.8
Cocoanut ..	76.5

In Sweden where Prof. Haunson's "Milk Unit" is adopted groundnut cake is found to be the best feed for fattening beef cattle and for milk production. In his method Prof. Haunson attaches more value to protein content than Kellner.

The following table gives the value of some cattle feed according to Prof. Haunson's Milk Unit :—

	Milk Units.
Groundnut cake	94.3
Cotton seed cake (decorticated)	87.2
Cocoanut cake	87.5
Palm kernel cake	72.4
Dried potato	72.6

The following table gives the results of feeding experiments conducted by Kellner with ruminants. They show the percentage of digestibility of different cakes :—

	Percentage of digestibility.			
	Protein.	Fat.	Carbo-hydrate	Total organic matter.
Groundnut cake	90	90	84	83
Linseed cake	86	92	78	79
Cotton seed decorticated ..	86	94	67	76
,, undecorticated ..	77	93	53	55
Rape	81	79	76	66
Cocoanut	78	97	83	80
Palm kernel	75	98	77	70
,, extracted ..	95	95	94	91

Groundnut Bran.

The thin seed coats generally go to make up groundnut bran. The bran contains about 14 per cent oil (*C. S. Fuchs. Chem. Zeit.*, 1911, p. 358). Sometimes bran mixed with ground shell is known as groundnut bran in Germany. Often ground shells are sold as such. Commonly seed coats, 20 to 30 per cent of material from the soft portion of the inside shell and a small percentage of kernel fragments are ground and sold as bran, containing 14 to 18 per cent oil. Bran with sack costs about £2 4*s*. to £2 8*s*. per ton. Inferior bran made of outer shell costs about £2 per ton.

Groundnut as Human Food.

The seeds are used either raw or roasted all over the world. Its nutritive value is as great as that of shelled sweet almonds. Except for the characteristic groundnut flavour it is very similar to almonds.

	Groundnuts.	Shelled sweet almonds.
Water	7.5	6.0
Protein	24.5	24.0
Oil	50.0	54.0
Carbohydrates	11.7	10.0
Cellulose	4.5	3.0
Mineral matter ..	1.8	3.0
Nutritive ratio	1: 5 : 17	1 : 5 : 59
Food units	198.0	205.0

In the United States of America pea nut butter industry has become very important and a very large quantity of butter is consumed in the States alone annually. The following table gives the analysis of the pea nut butter and round steak for comparison :—

	Pea nut butter.	Round steak.
Water	2.1	65.5
Protein	29.3	19.8
Fat	46.5	13.6
Carbohydrates	17.1	..
Ash	5.0	1.1
Fuel value, Calories per pound ..	2825	950

Pound for pound pea nut butter has a much greater food value than round steak though it sells for a lower price. It is wholesome and nutritious (Jaffa, in *Farmer's Bulletin*, 332—Nuts and their uses as food).

Groundnut meal also has a very high nutritive value and it is cheaper than many other foods. The following table gives their relative nutritive value and cost :—

	Nutritive value.	Price per 1000 units in centimes.
Cream	98.2	10.4
Lard	1,257.7	15.5
Butter	1,186.3	20.4
Beef	530.9	26.0
Peas	778.6	4.2
Rice	534.6	10.9
Groundnut meal ..	1,425.0	3.0

Groundnut is used in various forms. Many patent foods have been prepared and placed on the market. They are rich in protein, oil and contain a fair quantity of carbohydrates. Many attempts have been made to place on the market groundnut biscuits. On the whole, they are wholesome food products. Groundnut oil is largely used in packing sardines. It is also considered a good salad oil. In the margarine industry, there is a very keen competition between cotton seed oil and groundnut oil. If groundnut oil is available in sufficient quantity there is every likelihood of driving the cotton seed oil from this industry.

In 1914 the following quantities of oils were used in the margarine industry in Northern Europe :—

Groundnut oil	35,000
Cotton seed oil (American) ..	57,000
,, (others)	17,000
Sesame oil	32,000
Soybean oil	6,000
Rape oil	300

Groundnut Cake as Manure:

The manurial value of groundnut cake is very great. It is largely used for manuring sugarcane in Java and India. The market gardeners use it largely round about Paris in France. It is richer than decorticated cotton seed in nitrogen but slightly poorer in phosphoric acid and potash. Groundnut is supposed to produce good farm-yard manure and if the animals are fed on the land and all waste materials are collected, about 70 per cent of nitrogen is said to be available in the manure.

The following table gives the analysis of a few cakes and a sample of farm-yard manure for comparison :—

	N.	P_2O_5.	K_2O.
Groundnut	7.6	2.0	1.5
Cotton seed (decorticated) ..	6.9	3.1	2.0
Linseed	4.7	2.0	1.4
Soybean	6.8	1.3	2.2
Palm kernel..	2.5	1.2	0.5
Cocoanut	3.4	1.4	2.0
Rape	4.9	2.5	1.5
Farm-yard manure in Europe	0.4	0.21	0.5

As a general dressing the powdered pericarp is supposed to be good for meadows. It contains—

	%
N	= 1.0555
P_2O_5	= 0.287
K_2O	= 0.672

Generally pericarp contains about 59 per cent crude fibre. The total digestibility according to Kellner is 16 per cent. It is sometimes finely ground and mixed with concentrated feed in Germany to give bulk and help digestion. Generally they are burnt and the ashes are used as manure. Presence of broken kernels raise its manurial value.

Groundnut cake is largely used as a manure in Southern India for all commercial crops, especially for sugarcane. Tea and coffee plantations also have begun to use it in large quantities. There

are many mixtures for paddy or rice fields containing various proportions of super and groundnut cake.

To test the utility of cakes as manure in sugarcane fields various amounts of Castor and Hongay cakes were used for several years, the doses varying between 1 to 3 tons. Though with larger doses of manure bigger crops have been harvested the proportionate increase in the yield does not repay the extra cost of manure. On the basis of these experiments the amount of nitrogen required for a fair crop has been calculated and mixtures of groundnut cake and ammonium sulphate are given to the growing sugarcane in one or two doses. Even small doses of ammonium sulphate with groundnut cake induces free tillering of the canes and imparts a healthy dark green colour to the foliage.

Experiments on the Hebbal Farm, Mysore, India.

At present a general dose of 30,000 lbs. of farm-yard manure is given to the field. A ton of groundnut cake is given in two doses. The first dose is given at planting and the second dose at the time the rows are earthed up. Half the dose of ammonium sulphate also is given at planting time. The second dose of the manures is given when the canes are earthed up, and the tillerings have begun to form canes.

In the following experiment the canes were cut when they were 12 months old. The plots received a general dose of 30,000 lbs. cattle manure and one ton of groundnut cake. The yields are given in maund weights, and 1 maund weighs 25 lbs :—

Variety of sugarcane.	Tons of cane per acre.	Maunds of raw sugar (jaggery) per acre.
Red Mauritius ..	39.54	349.46
Local striped ..	33.77	302.63
Java	24.75	234.00
Cheni	38.62	237.00
P. O. Java 33 A ..	33.66	279.00

Another field was treated as above in general and received in addition ammonium sulphate at 2 cwts. per acre :—

Variety of cane	Tons of cane per acre.	Maunds of raw sugar (jaggery) per acre.
Red Mauritius—Cake ..	32.00	274.21
Cake+Am. Sulph. ..	43.05	373.45
H.M.14 Cake ..	27.73	259.29
Cake+Am. Sulph. ..	34.96	344.38
H.M.545 Cake ..	38.27	350.90
Cake+Am. Sulph. ..	40.73	381.07
H.M.312 Cake ..	37.06	275.00
Cake+Am. Sulph. ..	46.36	358.00
H.M.310 Cake ..	24.65	251.59
Cake+Am. Sulph. ..	39.02	345.71

N.B.—H. M. numbers of canes are the seedlings raised on the Hebbal Farm, Mysore State, India.

Experiments with Paddy "Rice".

Local variety of paddy was treated with the following manures. (Hebbal Farm, Mysore, India):—

	Yield per acre. Grain.	Straw.
	lbs.	lbs.
1. Cattle manure only ..	1,309	1,853
2. Cattle manure+420 lbs. Super ..	1,511	2,186
3. Cattle manure+420 lbs. Super as general dressing and		
(*a*) 250 lbs. groundnut cake ..	1,409	1,858
(*b*) 375 ,, ,, ..	1,542	2,204
(*c*) 500 ,, ,, ..	1,651	2,284

Large doses of cake alone merely encourage rank growth and prolong the period of ripening. The addition of super phosphate remedies this defect and increases the yield in most of the paddy fields. As phosphatic manure to be used with groundnut cake, super phosphate is to be preferred to bone meal.

	Grain.	Straw.
Green manure+Groundnut+Super ..	2,250 lbs.	3,975 lbs.
,, ,, +Bone Meal..	2,175 ,,	2,880 ,,

A mixture of 200 lbs. of groundnut cake and 160 lbs. of ordinary super is largely used by the Mysore paddy cultivator. Use of various doses of manure on the Nagenahally Farm (Mysore, India) gave the following results:—

Treatment.	1922-23. Grain.	1922-23. Straw.	1923-24. Grain.	1923-24. Straw.
	lbs.	lbs.	lbs.	lbs.
No manure ..	1,140	3,140	1,171	3,530
Paddy mixture 360 lbs. per acre ..	1,260	3,770	1,484	4,437
Do. 720 lbs. ..	1,550	4,690	1,538	5,033
Do. 1,080 lbs. ..	..	..	1,637	5,477

PADDY CROP.

In acid soils groundnut cake seems to give better results with basic super phosphate than with acid super phosphate:—

	Per Acre. Grain.	Straw.
1. Groundnut cake—250 lbs. +Acid Super 150 lbs. ..	1,420 lbs.	1,278 lbs.
2. Groundnut cake—250 lbs. +Basic Super 150 lbs. ..	1,627 ,,	1,408 ,,

On poor laterite soils in the heavy rainfall zone of the Ghat regions the following results were obtained. Average of 3 years' experiments:—

	Per Acre. Grain.	Straw.
	lbs.	lbs.
420 lbs. Super+250 lbs. groundnut cakes	1,409	1,858
+375 ,, cake ..	1,542	2,204
+500 ,, cake ..	1,651	2,284
Check. No manure ..	1,309	1,853

Areca Palm.

Manuring of areca palm gardens in the hilly tracts of Mysore has become a problem for want of sufficient amount of forest leaves and labour for transporting them from distant forests. As a result of experiments conducted for over three years, it has been found that groundnut cake with super and potash forms a very good mixture and feeds the palm to give heavy yields of nuts.

	Yield of dried nuts in lbs. per acre of 400 trees.
Check only forest leaves ..	536
Groundnut cake manure ..	757
Sulphate of Ammonia ..	765
Cake and Super ..	733
Sulphate of Ammonia and Super ..	760
Cake+Super+Potash ..	904
Ammonium Sulphate+Super+Potash ..	803

N.B.—General application of 2 tons of ground lime once in 4 to 5 years and farm-yard manure 20 lbs. per tree are given every year and mulched with leaves.

Super per tree ..	7 lbs.
Potassium Sulphate ..	½ lb.
Groundnut cake ..	1¼ lbs.

Mulberry.

The rearing of silkworm is a great industry in Mysore. With an improvement in reeling silk and rearing worms a need was felt to crop larger amount of mulberry leaf per acre. The rearers had a prejudice at first to use leaf produced by manuring with the groundnut cake, fearing that the caterpillers would die if fed on such leaves. Some enterprising people gave a fair trial and the method is now being generally adopted. In some cases nearly two to three times the usual crops have been picked after manuring with groundnut cake.

It is interesting to note here the manner in which groundnut cake is used as a manure in China round about Canton. Several hundred thousand acres are manured with groundnut cake in China annually. Usually one part of cake is soaked in two parts of water for about two weeks, after which the mixture is diluted and applied to mulberry plants in wooden spoons. Another method is to mix small quantities of Tea seed cake with groundnut cake, and soak

in water for ten days. It is then mixed with ten parts of water and applied to plants. The tea cake is supposed to ward off insects.

Many feeding experiments are under way to find out the requirements of milk cattle, working bullocks and horses. In all cases it is found that feeding with groundnut cake brings about a general improvement in the condition of the animal. It is only required now to find out the amount of ration and the percentage of bran necessary to mix with it. It is hoped that in a short time a scale of rations will be ready for the use of farmers and stock rearers. Such an information is quite necessary in the tropics where, often, seasons of drought drive the farmers to depend entirely upon concentrates to keep their live-stock going till the rains set in.

From the above discussion it is seen that groundnut is becoming a very important plant product satisfying the requirements of man all the world over in various ways. Its utility is such that an increased production is unlikely to produce a glut in the market. The rural population in the tropics is not in a position to include sufficient quantities of fat and protein in their daily food. The nutritive value of their food is very low. Animal food is costly. Sufficient quantities of animal fat are not available in most of the tropical countries. The tropical Africa where cattle diseases prevent stock rearing the indigenous population have no nutritive food to fall back upon. In the Asiatic countries many races are vegetarians and they are in need of foodstuffs, rich in oil and protein.

It has been felt that some cheap form of protein and fat is necessary for balancing nutritive value of the indigenous populations of Africa. The dietary of many races in Asia also requires a good deal of improvement. The successful cultivation of groundnut in the tropics solves the problem to a great extent. Groundnut has already occupied an important position amongst the farm crops. As a wholesome food for human consumption, as a good feed for feeding live-stock either for beef or for dairy products and as a good crop for rotation with serials, groundnut has become very popular. The growth of its popularity in the past has been amazing and the future is full of hopes.

Johne's Disease

BY

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Johne's Disease is an infectious bacterial dysentery affecting cattle principally but it may also affect horses, sheep, deer and goats.

The disease is prevalent mostly among cattle imported from outside, and it is not known definitely how long the disease has been in existence in India. It must have at least been more than a quarter of a century that the disease was discovered among some of the valuable dairy herds and, like tuberculosis, it is likely that the disease was introduced into this country through shipments of foreign cattle.

The disease is caused by the mycobacterium paratuberculosis, an ærobic, sporeless, non-motile and alcohol-fast bacillus which is usually found in nests and in large clumps in the affected parts of the intestinal mucous membrane and in the mesenteric lymphatic glands. The organism is similar to tubercle bacilli in its staining properties and like the lepra bacilli is alcohol-fast as well, but is smaller in size and lacks the beaded appearance seen in the tubercle bacilli. It is very difficult to cultivate this organism in the laboratory as it will only grow in cultures containing tubercular organisms.

The disease is spread from herd to herd by diseased animals introduced into clean herds, by community grazing and by feeding and drinking in common troughs. It is spread from animal to animal within a herd by bacilli expelled from the affected animal body with the fæces which contaminate the feed and water.

It is therefore very important that in planning for the control of the disease it is necessary to give special attention to the possible sources of infection, such as common grazing grounds, feed boxes, water troughs, feeding fodder in field lots on the ground, and even slow running and stagnant pools where animals have a chance of being infected.

Just how long a pasture may remain infected has not yet been definitely determined; obviously, it may be expected to vary under different conditions.

Although the period of incubation is not very definitely known it is believed that some animals may be infected while young—a few weeks old—and may not manifest the clinical symptoms until they are three or four years old or after calving. The disease is certainly a slow developing one and for that reason it is very difficult to combat.

The first symptoms usually observed in a case of Johne's disease are a temporary loss of appetite and in cows a radical diminution of yield of milk. This is followed by intermittent diarrhœa and progressive emaciation. The diarrhœa is increased progressively and fails to respond to all ordinary medicinal treatment employed for correction of such conditions. Gradually the coat becomes rough and the animal looks unthrifty. Sometimes the appetite may return after the first few days and remain normal thereafter but the diarrhœa will persist. No fever or rise of temperature is ever observed. The animal after some time becomes emaciated and dies as a result of exhaustion brought upon by superpurgation. Death is often hastened by calving and it has been observed that valuable pure bred herds and heavy milkers fall a ready victim as the vitality of the animal is lessened by the large quantities of milk production.

No satisfactory treatment of Johne's disease is yet known. In the earlier stages when the diarrhœa is intermittent temporary relief is sometimes obtained by restricting the feed and the use of astringent medicines. Oil of Chaulmoogra and its derivatives were tried with varying success.

Postmortem.

In advanced cases the carcase will be emaciated and a large effusion of serous fluid will be noticed in the abdominal cavity. A specific enteritis in both the large and small intestines may be present. It is generally the iliac portion of the small intestines that is most often affected. Sometimes inflammatory condition may not be seen but if the mucous surfaces are carefully examined in all chronic cases the walls will present an abnormal, wrinkled or corrugated appearance with thickening of the walls. The mesenteric glands are enlarged and on suction a milk-like fluid escapes. If a smear of the mucous membrane is examined microscopically millions of acid-fast organisms will be seen. The organisms are found irregularly

distributed in various sections of the intestines and certain parts are found to be preferred as nesting places. These are generally the jejunum, ileum, ileocæcal valve, rectum and the mesenteric lymphatic glands.

The disease may be confused with tuberculosis and parasitic diarrhœa. In these cases tuberculin test will eliminate the former and in the latter, the presence of worms and their ova will negative the diagnosis. Rarely, tuberculosis and Johne's disease exist in the same animal.

As cure cannot be expected, as has been described above, specific control methods should be adopted and it is necessary that early and effective steps should be undertaken by the State to minimise the loss to the live-stock industry from this disease as otherwise, from the nature of the spread of the disease, the incidence will be far more serious than in the case of tuberculosis.

The present knowledge of control methods is limited to testing periodically the presence of the disease in known herds and eliminating the reactors by slaughter and to ploughing up and liming the grazing areas and community pastures.

The test for the presence of Johne's disease is now carried on by means of avian tuberculin. The method is to inject a small quantity of avian tuberculin in a pinch of the fold of the skin and measuring the reaction for or against infection by the local as well as systemic reaction. But other methods are also followed in Western countries, notably by America, by the use of Johnin, an extract of the causal organism, as well as by serological methods.

From the foregoing it will be evident that once the disease is introduced into a herd it assumes serious proportions and causes severe loss to the dairy industry; it is therefore imperative that preventive measures should be promptly adopted. The Department will be glad to assist stock owners in testing to eliminate suspicious and carrier animals from the herd.

Some Additional Money Crops for the Shimoga Malnad

BY

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In the malnad taluks of the Shimoga District it is well known that the agricultural crops comprise practically only three, namely, areca, paddy and sugarcane. The cultivation of these crops is confined to the favourably suited protected valleys, that is to say, with an irrigation tank at the top or head of the valley in which rain or spring water can be impounded ; immediately below this irrigation source come the areca gardens, generally well protected by the steep sides of the valley ; then come paddy flats interspersed with sugarcane fields and lastly, as the valley widens out, an entire stretch of paddy flats, often liable to be flooded during the rainy season. But such favourably suited areas are naturally limited both in number and in extent. The district, however, possesses vast areas of land of a different class which at present are not put to any very profitable use. Leaving the great State Forests out of consideration for this purpose, there are large areas of '*kans*' which are virtually forest lands. In addition to the ordinary uses of forest land such as for providing fuel, light timber and grazing, they serve as what are called "soppin bettas" for the supply of the green leaves, which is a great need in malnad agriculture for use as bedding under the feet of cattle in the stalls and for spreading in the areca gardens about the base of the areca trees. There are in addition wide stretches of scrub and open land which are left waste, except such as may be close to the homesteads and are therefore used as grazing grounds.

Cannot these large areas comprised in these two classes be put under profitable crops and an additional source of income created thereby for the malnad ryot ? The results of some experimental work which has been in progress on the Government Farm in Marthur, Shimoga District, indicate some promising possibilities in this direction and a brief description may, I think, be found useful even at this stage.

The crops which have been deemed suitable for such areas are (1) Robusta Coffee, (2) Pepper, (3) Ginger. Robusta coffee and

pepper have been planted in the Soppin Betta or forest land belonging to the Farm. A very light clearing involving little or no felling of trees but only removal of undergrowth was done and the coffee planted in the usual way. A small portion, almost negligible, was also planted to "arabica," for the sake of comparison. The first planted area is now in the fourth year and the Robusta plants are quite well grown, healthy and vigorous and at present show profuse flower bud formation. They appear at this stage as normal as in the plantations in the regular coffee districts and may indeed prove equally of permanent value. A certain number of coffee plants have been planted out in the open also and though it is being grown under very difficult conditions on account of the lack of shade which had to be put in simultaneously with the coffee, even on that area plants on heavily mulched soil are well grown and vigorous—a result somewhat remarkable considering the exposed situation.

Under the trees themselves in the "Soppin Betta," pepper has been planted; the pepper cuttings were nearly all from the high yielding vines in the Farm. The growth of the pepper has been strikingly vigorous and though it is only the second year of planting many of the vines are bearing moderately good crops. This exceptionally noteworthy result is due to the nature of the cuttings planted. The plants look almost like the four-year old plants of the areca garden. The "Soppin Betta" of the Farm has therefore been put to the double purpose of growing coffee and pepper. It is gratifying to note that a demand for Robusta coffee seeds has arisen from the malnad visitors to the Farm as the result of their inspection of the Farm coffee area.

On the open dry land area of the Farm which is of the type represented by the scrub jungle and open grazing grounds of this tract, the cultivation of ginger is being carried on successfully. The heavy rainfall has not been harmful nor has the dry season found too trying for the crop. In the first year a yield of 101 maunds of green ginger per acre was obtained, in the second year the crop (still in the ground) promises to be a better one. Castor and garden togare were dibbled in for shade in the ginger area and contrary to fears that the malnad rains may be too heavy for these, they have made excellent growth and promise a good crop also. These results

are sufficiently encouraging to justify an extension in the area under ginger on the Farm. It will then be attempted to cure it all for marketing as dry ginger.

As the Farm is more or less typical of the rest of the Shimoga malnad, these results may be applicable to the large areas of land now being put to little or no profitable use, and if, as we hope, they be copied even on a small scale, they will be the means of adding materially to the income of the malnad ryot.

SELECTIONS

On the Growth of Cocoanut Roots

(From *Philippine Journal of Agriculture.*)

New roots of the cocoanut palm are produced above the old ones. These new roots are often exposed to the air by erosion due to the heavy rains, with the result that they become dry before they are able to reach the ground. Consequently the tree is dependent on the old roots already in the ground, and as these die off, its health suffers. It was found by experiments that covering the exposed and dried new roots with earth caused a renewal of growth, not at the original tip but slightly behind it. It is realized that earthing up a plantation of cocoanut trees would be expensive and probably impermanent. As an alternative, the use of cocoanut husks is suggested. These are usually piled between the trees and burned after each harvest or 3 or 4 times a year. They could therefore be utilized as a covering without extra expense. Experiments have shown that the husks so used will not form breeding places for the cocoanut beetle.—*Imperial Bureau of Fruit Production, Horticultural Abstracts*, Vol. II, No. 4.

Coffee Grafting

PRELIMINARY INVESTIGATION IN GRAFTING COFFEE AT AMANI, EAST AFRICA.

This paper describes various experiments which were carried out over a period of about eight months. Most of the experiments relate to grafts with *C. robusta* as the stock and *C. arabica* as the scion. At first, the main object in view was to discover whether grafting coffee could be successfully accomplished under the conditions prevailing at Amani. Results proved that successful grafting is fairly easy to accomplish and the suggestion is advanced that grafting could also be carried out successfully in other coffee producing districts.

For grafting twelve to eighteen months old seedlings in the nursery beds, and stumps, or suckers in the field, the best type of scion is said to be obtained from the firm green wood of " chupons " between the mature brown wood to within nine to six inches of the tips. Each scion consists of a single node and four inches of the internode, the number of scions yielded by a "chupon" depending on the strength of the shoot and degree

of ripeness of the wood. The best union was obtained by grafting on the stock at a point where the wood was firm and green and slightly older than the scion. In most of the experiments the ordinary veneer method of grafting was used.

When grafting was carried out during the rainy season it was not so successful as at drier periods and the theory is advanced that the ideal period for the operation is the cool, dry season, between the months of June and October.

Elaborate protection of the grafts is considered to be unnecessary and the method of using paper cylinders dipped in paraffin wax, which is reported to be successful in Java, is interesting from the point of view of cheapness. This method also eliminates the use of grafting wax.

A method of grafting *Coffea arabica* on to other species when both stock and scions are seedlings, at the cotyledon stage of growth, is described. No part of the stock was removed. A vertical cut was made through the plumule and the hypocotyl so that the cotyledons fell apart. The seedling forming the scion was severed just above ground level and the hypocotyle cut to form a long tapering wedge. The point of the wedge was inserted at the bottom of the slit in the stock so that all the cut surfaces were parallel. When the cotyledons of the stock were brought to their original position and the whole bound with a thin strand of raffia, the finished graft had the appearance of a seedling with two pairs of cotyledons, one above the other.

It is claimed for this method that (*a*) a very large percentage of successful grafts can be easily obtained, (*b*) no elaborate nursery apparatus would be required, and (*c*) that the operation would become a fairly speedy one after some practice by the operator.

Further data as to the subsequent behaviour of the plants in the field will, of course, be necessary, before this method of grafting can be justified.

Since this original paper was written the suggestion that the dry season is the best time for grafting receives considerable support from two recent publications. The authors state that the surface feeding roots of the coffee plant are least active during the rainy seasons. In view of this data it is almost certain that the larger number of successful grafts obtained during the dry season was due, not to better conditions prevailing above ground for the actual union between stock and scion, so much as the greater activity of the feeding roots causing a maximum flow of sap in the stocks at that period.—K. E. T., *Tropical Agriculture*, Vol. X, No. 3.

Potato Growing in Victoria

By J. T. Ramsay, *Potato Expert.*

In the cultivation of potatoes, there are three factors within the control of the farmer and which govern the yield. These are:—

1. Condition of the Seed.
2. Physical Condition of the Soil.
3. Plant Food in the Soil.

These factors are all-important. The abundance of plant food, and the perfect condition of the seed, will not produce a full crop if the physical condition of the soil be bad; and, similarly, a low standard of fertility of the soil, or of the vigour of the seed, will give a disappointing return, even though the other two factors be correctly adjusted.

Condition of Seed.

The varieties of potatoes on the world's markets are legion, and year by year the number of these is being added to by propagators, who diligently and continually seek after new sorts, which, it is hoped, will eclipse the records of current or past varieties.

Many growers are ever anxious to test new sorts, and buy up any variety produced which gives promise of profit by virtue of its having, in an outstanding degree, one or more of the features which make a potato desirable from the cultivator's point of view, *viz.*, earliness in maturing, good cooking quality, strong disease resistant power, and productiveness. But no sooner do the majority of growers procure a new variety worthy of attention than they, by their treatment of it, proceed to "run it out" with all possible speed.

Degeneration is Preventable.

There is no reason why any good variety of potato should not remain in cultivation as long as growers remain to cultivate it. Once a grower secures a variety that suits his local conditions, he should so treat it that rather than "run out," it will tend to improve as time goes on.

The length of time any particular kind of potato remains in profitable cultivation is governed by two things, *viz.*, the treatment it receives and its vigour at the time of its introduction.

Some varieties are more vigorous than others when produced from the seed-berry of the potato plant, and consequently can stand more adverse treatment before falling into a condition of low productiveness, than can those of less vigour. But no matter how vigorous any variety may be, it cannot withstand the degenerative influence of bad or unselected seed.

Breeders of good stock aim at reproducing only from the best types available to them, and if continual selection of the best were not made, degeneration would quickly follow. Growers of plants are under the same law. Like, for the greater part, produces like. Yet one often finds, being used for seed, potatoes which could be more profitably used as stock food.

When poor conditioned seed is employed to grow any crop, that crop is so handicapped that its finish will be disappointing. A very large proportion of the crops grown in the State start with seed of impaired vitality. To illustrate that this is not an exaggerated statement, it is necessary only to review briefly the common practice amongst growers.

Ordinarily potatoes are allowed to ripen in the ground before being dug, and the seed for the following season is selected either from the crop after it has been bulked, or from the rejects from the marketable tubers. After this "selection" has been made, the seed is generally stored in any place where it can be conveniently disposed of, in heaps, bagged or pitted, and is often forgotten until required for sowing. The result is that by that time the potatoes intended for seed have a mass of long, delicate, white shoots, many of which are broken off in the handling incidental to planting, and, in many cases, the remaining sprouts are carefully and deliberately removed by the growers. The object in breaking off the balance is, of course, to prevent the irregular appearance of the crop above the ground, and with such an object in view, the practice of desprouting serves its purpose, *but the seed suffers.*

Where such methods are followed, it is evident that the best seed cannot be secured, since after the produce of a field of potatoes has been bulked, it is an absolute impossibility to discriminate between the produce of strong-growing, prolific plants, and that of weak plants.

For economical reasons, small-sized tubers, *i.e.*, tubers under the size marketed for table use, are often taken for seed. There is no objection to the use of small-sized seed provided proper selection of it is made. The necessity for selection becomes apparent, however, when it is pointed out that there are two classes of small potatoes. First, there are those which are small because of some weakness of the parent plants; and, second, those which are the later-formed tubers of strong plants which have not had time to develop to full size. As it is impossible to separate these two classes once they are mixed, it follows that, if selection is made of seed after bulking of the crop, the seed parcel will contain a yearly increasing percentage of the produce of plants of low-yielding power, with the result that the particular variety being so treated will

give progressively diminishing returns, until it becomes entirely unprofitable, or "run-out". Even where large-sized seed is used, and selection made from bulk, there is the same risk of inclusion among the seed of the produce of weak plants, as very often a weak plant will give only one or two tubers of fair size and perfect shape, but of poor constitution.

In actual tests carried out at Millbrook during 1932 and 1933 the average increase obtained from selected seed was 44 per cent, all other factors except the seed being equal. In the seven years' period over which the seeds have been tested, the following average yields have been obtained, the average increase resulting from the case of selected seed being 1 ton 19 cwt. per acre, or 35 per cent increase on the yield from unselected seed.

YIELD.

	Tons.	Cwt.
Selected Seed	7	8
Unselected Seed	5	9
Average increase	1	19

Percentage Increase, 35 per cent.

NOTE :—The weights recorded are for market-size tubers only.

SEED SELECTION.

There is but one method by which potatoes may be selected for seed, so that the standard of trueness to type and yielding capacity may be maintained unimpaired, and that is, by selecting from the field crop *while the crop is green and growing*, the seed intended for the following season's planting.

Seed selected in this way can be chosen from the most desirable plants, *i.e.*, those plants which are healthiest, most vigorous, and producing the greatest number of marketable-sized tubers. Seed selected from such stock must produce plants of more vigour than seed taken promiscuously from a heap where fit and unfit are mixed.

The average grower of any quantity of potatoes may be inclined to think that this entails more trouble and cost than the crop is worth, but it is not so. For those who plant large acreages each year, and who, therefore, require many tons of seed, the work of selecting can be carried out in the following manner :—Suppose a grower plants 50 acres of potatoes yearly ; that in normal seasons he gets 5 tons per acre, and that he wishes to select his seed with a view to improving his stock. At the rate of sowing of 12 cwt. per acre, it takes 30 tons to plant 50 acres. Now 6 acres of crop, at 5 tons to the acre, gives 30 tons, therefore, if sufficient seed for 6 acres, *viz.*, 3 tons 12 cwt., were rigidly selected each year, and a

6-acre area planted with them, the grower would have yearly a stud plot producing tubers of a high standard sufficient to plant the whole of his 50 acres. For the purpose of illustration, the rate of planting has been taken as 12 cwt. per acre, but this may vary according to the size and the spacing of the sets. The probability is that the rate of production of the stud plot, too, will vary, and be nearer to 10 tons, on the average, than the 5 tons mentioned in the calculation.

Immature Seed Increases Yield.

In harvesting any potatoes intended for seed, care should be taken to dig the tubers out of the ground before they are mature. As a rule, the seeds of plants require to be thoroughly ripened before they are best able to reproduce their kind. The potato "seed", however, is not the true seed of the potato plant. This is contained in the berry, which is produced above ground. The potato "seed" used for planting is merely a section of the previous season's plant, and is, therefore, really a cutting, and not a *seed*. The improvement in the yield from immature seed, as compared with ripe seed, has been so long and clearly demonstrated, that the practice of securing seed, dug before the ripening of the plants, has been thoroughly established for some time in countries where a speciality is made of potato culture.

On the average, the increase in the crop resulting from the use of immature seed is from one and a half to two tons per acre, and as the average yield for the State under methods at present employed is only about 3 tons per acre, it can be seen that the profit awaiting farmers who will adopt this more up-to-date practice must be admitted to be well worth the little extra trouble involved.

The best time at which to harvest potatoes intended for seed purposes is when an indication of ripening is shown by the first yellowing of the leaves. Harvested at this stage, a sufficient degree of maturity is obtained to give the desired increase in yield, while but little weight of crop is sacrificed. Care should be taken to differentiate between the yellowing of the leaves from natural ripening and the yellowing caused by disease or insect trouble.

No explanation can be given of the higher efficiency of immature seed, but the fact is sufficiently demonstrated for acceptance without any scientific support. As a matter of fact, the higher value of immature seed as compared to ripe seed was noticed and appreciated by Scottish growers more than half a century ago.

Experiments at Millbrook and in other portions of the State afford ample evidence as to the value of immature seed in increasing crop yields.

In these tests market-size tubers only are taken into consideration, yet the results show over an eight-years' period an average increase of 27 per cent in favour of immature seed. The actual figures are as follows :—

AVERAGE YIELD, EIGHT YEARS.

	Tons.	Cwt.
Immature Seed	8	5
Ripe Seed	6	9
Increase	1	16

Percentage Increase, 27 per cent.

(To be continued.)

—The Journal of the Department of Agriculture, Victoria, Australia, Vol. XXXI, Part 3.

World Industry in Cocoanut Palm Products

ABSTRACT OF "SURVEY OF OIL SEEDS AND VEGETABLE OILS," VOL. II.

COCOANUT PALM PRODUCTS.

The estimated world's acreage under cocoanuts in 1930 was about 7¼ million acres as compared with 5½ million acres in 1921, an increase of about 30 per cent during the 10-year period. In both years the British Empire countries accounted for slightly more than half of the world acreage.

WORLD PRODUCTION AND EXPORTS OF COPRA.

An estimate of the world production of copra based on the figures of acreage and the assumption that 2½ acres of palms yield one ton of copra shows that about 3 million tons of copra are now produced annually. It is estimated that over 40 per cent of the total production is consumed in the countries of origin.

World exports of copra declined from 1.17 million tons in 1928 to 1.04 million tons in 1930 and, it is stated in this survey, the exports of 1931 were expected to show a further slight decrease. This slight decline is in part due to the increased production of cocoanut oil in the copra-producing areas and to the diminution of prices in the world markets.

Netherlands India and the Philippine Islands supplied nearly 65 per cent of the whole before the war, whereas they now supply little more than 50 per cent whilst British Empire countries have increased their combined shares from 20 per cent to 40 per cent of the whole. Malaya, in 1930, produced 10 per cent of the world supplies.

WORLD EXPORTS OF COPRA AND COCOANUT OIL.

Owing to the rapidly increasing export trade in cocoanut oil from copra-producing countries in recent years, the figures for this commodity should

be considered together with those of copra in order to obtain a comprehensive view of the situation. This increasing export of cocoanut oil indicates that the crushing industries in the copra-producing countries are successfully competing with those in the centres of consumption and this tendency may be expected to increase, since labour is generally cheaper in the countries of origin. Furthermore, the oil produced from fresh copra has a lower free fatty acid content than that produced from stale copra which has been stored for lengthy periods. Exports of cocoanut oil from copra-producing areas now exceed 200,000 tons per annum of which the British Empire countries furnish over 20 per cent. The Philippines and Ceylon are by far the chief copra-producing countries exporting cocoanut oil, the former exporting about 60 per cent of its total copra production as cocoanut oil.

The total net world exports of both copra and cocoanut oil in terms of copra* reached a peak of over 1½ million tons in 1929, declining to 1⅓ million tons in 1930, of which, in 1930, 23.2 per cent was in the form of cocoanut oil.

The percentage share of cocoanut oil in the aggregate exports was 19.8 in 1926, 23.6 in 1927, 22.3 in 1928, 26.4 in 1929 and 23.2 in 1930.

Comparative Exports of Different Countries.

Although Netherlands India is by far the largest exporter of copra, when exports of copra and cocoanut oil are combined the greatest share of the world supply of both commodities entering international trade is that of the Philippines which was 29.3 per cent in 1930 as compared with 28.6 per cent from Netherlands India in the same year. The next most important shares are those of the British South Sea Islands, Ceylon, and Malaya which supplied 11.6, 11.1 and 8.7 per cent respectively.

It is interesting to note that the next most important share of supply of the two commodities is that of the foreign territories of the South Sea Islands which, in 1930, amounted to 3.2 per cent of the whole.

Principal Copra Importing Countries.

Before the war, Germany was the principal importer of copra with France a close second. After the war, Germany recovered her premier position for a short period but lost it to the United States of America in 1926.

In 1931 net imports of copra in thousand tons, into the principal importing countries were:—United States 192, France 192, Germany 143, Netherlands 85, United Kingdom 80, and Denmark 70 thousand tons.

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* 65 tons of cocoanut oil equals 100 tons of copra.

Consumption of Cocoanut Oil in the Principal Consuming Countries.

The demand for cocoanut oil is largely dependent upon the margarine and soap industries and the available figures of margarine production indicate a marked reduction in the past two years. Soap production has been much more stable than that of margarine in recent years and the popularity of hard soaps has resulted in an increasing proportion of cocoanut and palm kernel oil in the raw material utilized. The utilization of these two oils in the soap industry is likely to increase if this tendency continues and the choice between the one or the other will be largely decided by their relative price movements.

The consumption of cocoanut oil in the principal consuming countries outside the copra-producing areas reached a peak of 870 thousand tons in 1929. In 1930 there was a decrease of about 14 per cent in the consumption and a further decline of about 5 per cent in 1931.

Other Cocoanut Products.

Fresh Cocoanuts.—The trade is comparatively small and localized. About 110 million nuts were exported in 1930 for consumption as nuts and for shredding. Jamaica, Ceylon and Malaya are the principal exporters and the United States is the principal importer.

Shredded and Desiccated Cocoanut.—Ceylon and the Philippine Islands are the sources of supply, about 50 thousand tons being exported from these countries annually.

Coir.—Ceylon and India are the chief exporters of this commodity. Exports from the latter country are almost entirely in the form of manufactured products.

Cocoanut Cake and Meal.—The main sources of world supply are Ceylon, India, Netherlands India and the Philippines. The amount exported now exceeds 150 thousand tons.

Demand for Cocoanut Products in the United States of America.

Cocoanut oil is by far the most important ultimate product of the cocoanut palm and the future prospects of the industry depend almost entirely upon the demand for this oil. The war and post-war periods have witnessed a heavy increase in demand which has been largely the result of developments in the United States of America. Since the war that country has been the largest single consumer of this commodity, about one-third of the world's supplies now finding their outlet there. American demand is largely satisfied by Philippine production, and Philippine production is largely absorbed by American demand. Since

1925, Philippine produce has constituted about 80 per cent of the estimated volume of cocoanut oil consumed in America, and America has taken between 80 and 90 per cent of the Philippine exports of copra and cocoanut oil. It is thus clear that the United States of America and the Philippines, as far as cocoanut palm products are concerned, constitute almost a self-contained group and that the cocoanut palm industry outside the Philippines is likely to remain very largely dependent upon European consuming centres as an outlet for its surplus production.

Recently, a further aspect of this question has revealed itself, namely, the effect of a substantial reduction in the American demand for cocoanut palm products. The decrease in the apparent consumption of cocoanut oil in the United States during the present depression has released appreciable supplies of Philippine produce for marketing elsewhere, particularly in Europe, since the American consumer can, of course, reduce his demand much more rapidly than the Philippine producer can reduce his supply. As a result, exports of Philippine copra to France, for instance, increased from an average of about 7,000 tons in the period 1928-30 to 22,000 tons in 1931, and exports of Philippine cocoanut oil to the United Kingdom increased from an average of about 250 tons in the period 1928-30 to about 14,000 in 1931. This development shows that although the United States and Philippines are largely inter-dependent as regards cocoanut palm products, maladjustment between supply and demand can have repercussions on the other producing and consuming areas, and that if American demand fails to keep pace with Philippine production—there were in 1931 over 200,000 acres of cocoanut palms in the Philippines not yet in full bearing—the European market may find itself subjected to a substantial increase in the offerings of Philippine copra and cocoanut oil, to the detriment, of course, of marketing possibilities of the produce of other cocoanut areas.

Demand in Europe.

Since 1924, there has been no evidence of any marked increase in the demand for cocoanut oil in the European countries taken as a whole. The apparent consumption in the United Kingdom, France, Germany, Denmark, Italy, Norway, the Netherlands and Czecho-Slovakia, which constitute the most important consuming centres of Europe, amounted to about 400,000 tons per annum in the period 1924 to 1927 and about 430,000 tons per annum in the period 1928 to 1931. The development of demand in Europe has been seriously hindered by the increase in supplies of groundnuts and other competing oilseeds, but particularly by the heavy production of whale oil which is largely absorbed in the European

margarine and soap industries. Whale oil production increased from 130,000 tons in 1924-25 to 600,000 tons in 1930-31. The serious price fall in whale oil in recent years has resulted in drastic cuts in the whaling plans for 1932-33, the estimated production for which is 300,000 to 400,000 tons, and if these plans materialise the European demand for cocoanut oil should appreciably benefit.

Future Supplies.

A longer view of the situation suggests that the supplies of cocoanut palm product should continue to expand as the areas under cultivation, which increased by about 30 per cent between 1921 and 1930, come into full bearing. Moreover, the world exports of copra and cocoanut oil in 1930 and 1931 were much below the peak of 1929, thus indicating that supplies could in any case readily respond to an increase in demand. Future supplies are therefore assured, and the expansion of demand is undoubtedly the principal factor upon which the future prosperity of the industry depends. The demand for cocoanut oil, which, as has already been pointed out, is by far the most important form in which the cocoanut enters into final consumption, depends on the one hand on the growth of the soap and of the margarine industries and on the other hand, on the competition of other vegetable oils and fats and animal and marine fats utilized in these industries.

Substitution of Cocoanut Oil by Other Oils.

The expansion of the soap and margarine industries should continue with the general increase in population and with a resumption of the rise in the standard of living. As regards the substitution of one oil or fat for another in these industries, the prospects are not so easy to define. Substitution is primarily dependent upon the special properties which the competing fats possess and with the widened uses for inferior oils brought about by improvements in technical processes. The large increase in the share of cocoanut oil in the oleo-margarine industry in the United States of America and its increased utilization in the soap industry of the United Kingdom in recent years may be attributed to the special characteristics which it possesses and the special qualities which it gives to these commodities. But price considerations also play an important part in the choice of substitutable oils and fats, and over a relatively short period the price factor is probably the more potent. It remains to be seen whether the net results of the efforts being made to reduce the costs of competing vegetable oils and the probable rise in price of animal and marine fats resulting from the restriction in the world's live-stock population and the whaling catch will be such as to permit of the

more effective competition of cocoanut oil with suitable oils and fats such as tallow, palm oil, palm kernel oil, groundnut oil, cotton seed oil and whale oil.—H. D. M., *The Malayan Agricultural Journal*, Vol. XXI, No. 3.

Sesamum

Sesamum has always been amongst the most important of the oil-yielding plants. Of recent years, however, the demand for sesamum seed and oil has been steadily declining owing to the increase on the market of oils from other plants such as the oil palm, copra, and the groundnuts. The cultivation of sesamum continues, however, to be of importance to a large part of the population in countries with tropical and temperate climates. In view of the difficulty in finding full information about the crop, its culture and its commerce it would appear to be of use to indicate certain publications which supply a number of interesting details. The greater part of the facts given below were obtained from the books of Von Sprecher and Del Nero and from the articles of Eberhardt, Castaidi and De Tyssonck.

Botanical Aspects.—Sesamum indicum D.C., belongs to the small family of the Pedaliaceæ which contains herbs with bluish-green, simple, opposite or alternate leaves provided with mucilaginous hairs.

Linnæus distinguished two species—*Sesamum indicum* L. and *Sorientale* L.; De Candolle combined them into a single species, *Sesamum indicum* D.C.

The plant is an annual reaching usually a height of about 5 feet. In India, however, it may reach double that height and have stems the thickness of an arm. The stem is straight, square in section, branching a certain number of times. The leaves are polymorphic, dentate or entire; the lower leaves are sometimes ternate. The flowers are in the axils of the leaves. Of the 3 flowers usually only one develops; the corella is bi-lobed; only 4 of the 5 stamens develop. The colour of the flower varies in different varieties. Howard distinguished 4 colours:—deep violet, white tinged with violet, white with violet margin and pure white. Flowering is from the base of the stem upwards and of short duration. About twenty flowers open each morning and are withered by mid-day.

The fruit is an oblong, bi-locular capsule, each loculus being sub-divided by a false septum. It is septicidal and splits downwards from the top leaving the central wall with the seeds free. The seeds are very numerous, oval and flat. The colour varies; according to Eberhardt the

same variety will give lighter-coloured seeds in low land than in the mountains. The seed coat encloses an embryo with clearly distinguishable cotyledons and radicle. Albumen is little developed.

Microscopical study of the seeds shows that the cells of the epidermis contain on the outer side a crystal of calcium oxalate and a pigment on the inner. The cells of the albumen and embryo contain oil and starch grains.

Varieties.—It has already been mentioned that the shape of the leaves and the colour of the flowers and seeds are variable. All these variations are affected by climate, soil and cultural treatment. It follows that in introducing seed from a country known for its high yield there can be no certainty of the good qualities being reproduced unless the climate and soil of the new country correspond to those of the country of origin.

At Tatkon in Burma selection work has been begun and 175 types of sesamum have been isolated and reproduced without cross pollination. It was observed in the course of the selection work that varieties with a marked tendency to branching are more resistant than those with a less branching habit. In Asiatic Turkey for a number of years preference has been given to certain so-called varieties, which are in reality only phenotypic modifications, amongst which the best are the "Cassaba" and the "Adin". In British India the following variations may be distinguished:—

(1) "Suffed-til" or "vel-ellon", with a light-coloured seed. This variety is grown on flood land in the plains; it yields a fine clear oil.

(2) "Tillee" or "per-ellon", with a black seed, is grown in the higher regions. It has the highest oil content and so is preferred for cultivation. The greater part of the Indian oil, which is always slightly cloudy, comes from this variety.

(3) "Kala-til" or "kour-ellon", with a reddish seed, is the sesamum of the red soils; the oil is of inferior quality but the variety is somewhat widely cultivated because it will grow on poor, dry soil where the other two varieties will not succeed.

The natives of Java distinguish two varieties:—

(1) The "widjen sapi", with a cylindrical stem, narrow leaves and brown seeds;

(2) The "widjen kebo", with a stem square in section and black seeds.

Origin, History and Name.—The name sesamum comes to us from the Semitic peoples. It is probable that the "Open, Sesame" of the "Arabian Nights" is a reference to the sesamum capsule which until ripe will

not open. The crop was thus known to the Arabs; but it comes from much further afield, from India and the Sunda Islands. From India sesamum was introduced into the region of the Euphrates; Herodotus, and later Strabo mention the existence of the plant there. On the other hand, according to Von Sprecher, the sesamum was not known in ancient Egypt. The Jews must have imported it from the Euphrates valley and it is highly probable that later it was introduced from Palestine into Egypt. Among Latin writers Pliny and Columella mention sesamum and even give some information regarding its culture. Its introduction into the other countries where it is found to-day is of later date. In China it has been known only during the Christian era. The Portuguese have carried it to Brazil.

There are two theories concerning the origin of sesamum. That of Eberhardt puts its origin in India and the provinces with temperate climates to the north of the Himalaya and Karakorum mountains from where it spread in 3 directions, namely:—

(1) To Southern India and Ceylon, and from there was carried by the Chams, a Buddhist sect, to Java and Borneo and the southern part of Indo-China;

(2) to the West into Iran, Persia, Mesopotamia and finally into Asia Minor and Egypt;

(3) to the East into China and Japan.

The other theory that of Ascherson and Hammerstein, supposes an African origin. It is based on the fact that of the 12 known species of the genus *Sesamum* 10 occur in the wild state in Africa. Widespread distribution would thus have occurred in prehistoric times.

The old theory of De Candolle may also be mentioned, according to which the plant originated in the Sunda Islands; but there is little probability in this hypothesis.

The names given to the plant in different countries may perhaps throw some light on the history of its migrations. The ancient Sanskrit name was 'tila', which is the name still used by the Brahmins. In the Indo-Malay archipelago there occur a number of names which may be divided into two groups as follows:—

(1) The Malay term "lenga" with many variations such as "lengong" (Atjet), "longa" (Nias), "linga" (Bima), "lena" (Ceram). According to Eberhardt these are transformations of the Sanskrit root "til".

(2) The Javanese name "widjien".

The name used in India is "gingil" or "gingelly", a word from which are probably derived the Arab word "giulgiulan", the Italian words "giuggiolena" (Tuscany), "guggiulena", and "giurgiolena"

(Calabria and Sicily) and the Portuguese names "gengelim" and "gergelim" used in Brazil. The Japanese name is "koba", the Chinese, "moa" or "chima"; the word "me" which is met with in Tonkin, over the Chinese frontier, throughout Annam and in the whole delta of Cochin-China is nothing but a local corruption of the Chinese "ma". All the other names encountered are slight variations of the sesamum.

Environmental Conditions.—Sesamum is grown throughout the tropical and subtropical zones. Cultivation is still possible in Greece, Southern Italy, and in the southern States of the United States of America.

A few hot summer months suffice for the development of the plant which, according to the temperature, gives a crop $3\frac{1}{2}$ to $4\frac{1}{2}$ months after sowing. It will not stand low temperatures. A mean annual temperature of 20°C. is necessary. The total requirement during 120 days is 2,700°C. In Italy sesamum takes $3\frac{1}{2}$ months to complete its growth cycle. In Central Italy it requires even 4 to $4\frac{1}{2}$ months. It grows well in regions where maize ripens between September 10 and 15. Del Nero cites an 18th century writer Bolognini, according to whom sesamum plants of the height of a man were to be seen at Bologna in 1760.

Rain immediately after sowing is liable to be harmful but the plants require a considerable amount of moisture during the early stages of growth. If the ground is too dry irrigation is recommended. During the flowering and ripening periods no moisture is required.

Wind is not well withstood, and for this reason the crop is never a success in the south of France.

It has been recognized for a long time that sesamum prefers sandy soils which are porous and rich in lime. By pot experiments in India Ram Kashi and Madhava Row have shown that the observations of growers are correct. Two varieties, one early and one late maturing, were grown in soils of differing composition. The series of experiments included (1) a clay soil from a rice field; (2) $\frac{3}{4}$ of the same soil mixed with $\frac{1}{4}$ of sand; (3) $\frac{1}{2}$ of clay, $\frac{1}{2}$ of sand; (4) $\frac{1}{4}$ of clay, $\frac{3}{4}$ of sand. The results showed in a striking manner the preference of the plant for sand. Figures and photographs are given showing that the plants of the 4th series reached the maximum height and formed the greatest number of lateral branches and capsules; the root development also was greatly superior to that of the plants grown in more or less clayey soils.

Culture.—Sesamum is grown either in rotation with other annual crops such as rice, wheat or cotton, or as a secondary crop associated with rice and maize, as in dry fields in Java and Sumatra; with cotton,

maize and vines in the island of Cyprus. In Brazil sesamum is sometimes grown in coffee and mate plantations.

Sowing.—The seed-bed must be well prepared by ploughing followed by harrowing. Von Sprecher recommends the use of chemical fertilizers where manure is not available. The seed is sometimes scattered broadcast; it is better, however, to sow in rows 2 to 2½ feet apart. In Java the seed is mixed with ash to prevent their sticking together and also as a protection against insects. A sufficient quantity of seed must be used; if the seedlings come up too thickly they can be thinned when they are a few inches in height. The seed being very light, 6 to 10 kg. per hectare are sufficient.

Cultivation.—The seeds germinate after 10 days. The seedlings are very delicate and cannot stand heavy rain. A first hoeing is combined with thinning out. Later the plant prevents by its own rapid development the competition of weeds.

Diseases and Pests.—Very few pests are known. Von Sprecher mentions *Epilachna chrysomelina* F. which in Africa injures the leaves, flowers and capsules; the caterpillars of *Acherontia lachesis* F. and *A. styx* Westw., which has been found on the leaves in eastern Asia; and *Aphis gossypii* Glov. which may migrate from cotton to sesamum. De Tyssonsk mentions the "walang sangit" (*Leptocoriza acuta* Thum.), a bug which is associated with a disease known as " omo doean boendel", which damaged 50 per cent of the plantations of the Residences of Rembang and Blora in 1928, but is not known elsewhere.

Harvest.—As ripening is prolonged over a considerable period the harvest presents certain difficulties. The best method would be to gather the capsules in succession as they ripen, but this would entail too much labour. Other systems therefore are used; either the plants are pulled up, when the majority of the capsules are ripe or the whole field is reaped. Eberhardt describes the method used in Indo-China as follows :-"The plants are, according to the locality, either reaped level with the ground or simply pulled up, but always some time before the fruits are ripe; the plants are made into bundles and carried indoors. There they are left in small heaps, with care to prevent their receiving too much sunshine. They are often covered over with matting. A kind of fermentation sets in which makes the leaves turn yellow and fall, and finally only the stems are left bearing the capsules. They are then removed on the matting and exposed to sunshine, sometimes with bamboo laths under the matting. The sun speedily bursts the capsules and frees the seeds of most of the fruits. A certain number, however, sometimes do not open with the same facility; these are then made to dehisce by the natives

who beat the capsules with a small wooden mallet or in other regions pass wooden rollers over the matting. By these means no capsules is allowed to escape dehiscing. Women and children then separate the seeds from the debris."

Yield per Hectare.—It must be realized that the published figures can be only approximate. Sesamum being usually a secondary crop it would give a false idea of the yield per hectare to give simply the relationship of production to area. The following figures must therefore be accepted with reserve. Von Sprecher mentions yields varying between 750 and 2,500 kg. De Tyssonsk gives 300—350 kg. for Java. Del Nero speaks of 1,000—1,800 kg. and cites Bochicchio who gives 1,500—2,000 kg. for Sicily. In China 300—500 kg. are estimated. The average yields in India are undoubtedly lower. It is highly probable that by scientific selection and by seeking types adapted to local conditions the yields could be improved.

Oil Extraction.—The sesamum seed exported to Europe and America is pressed in large oil mills by hydraulic machinery. The various stages in the process are as follows :—

1. Cleaning of the seed.
2. Crushing the seed between rollers.
3. First pressing for 1-1½ hours.
   This produces 22-32 per cent of a fine clear table oil.
4. Milling the cake with 4-5 per cent of water, then a second pressing for 1 hour.
   This gives 6-12 per cent of darker coloured oil which is marketed as table oil of less fine quality.
5. Repetition of the preceding operation followed by heating to 50°C. Then a third pressing, giving 8-10 per cent of a dark oil which is used in the soap industry.

The oil cake from the third pressing still contains 8-10 per cent of oil which may be extracted with carbon disulphide. The oil is very dark coloured and is used in soap making. The cake cannot be used as a stock feed but only as manure.

The methods of extraction used in the producing countries are primitive for the most part. The mills used in India are described by Eberhardt and Von Sprecher with good illustrations. In Indo-China and Java the natives use presses or mortars. It is obvious that with such primitive methods complete extraction cannot be obtained; 22 per cent only of the oil contained in the seed is extracted. The oil is moreover darkened by the colouring matter of the seed-coat. Two methods of preventing this colouration are in use. In Indo-China the seed is boiled

before pressing to extract the colouring matter. In Syria the seed coat is removed by the following process :—

1. Steeping the seed in water for 24 hours.
2. Beating the softened seed with wooden slats to separate the seed coat.
3. Treating the mass with salt water, when the seed coats rise to the surface and can be removed.
4. Washing the kernels to remove the salt.
5. Drying the kernels in an oven.
6. Grinding the lightly roasted kernels in a mill till a solid puree is obtained.
7. Pressing by treading.

By these means 45 per cent of the oil is extracted.

Uses and Composition of Sesamum Products.—(1) *Seed.* In the producing countries the seed is used for food. It is sprinkled over bread as a flavouring. In India it is added to rice and millet. In Africa the pounded seed is used as a seasoning for vegetables. In Egypt and Asia Minor a soup is made from sesamum seed. In Palestine sesamum meal is used with lemon peel and honey to prepare " chalbe ", a Lenten dish.

The seed is also used medicinally by the natives in the Dutch East Indies.

The chemical composition of the seed is very variable. The average is :—Water 5 per cent, protein 20 per cent, fat 35—57 per cent, non-nitrogenous extractives 14—22 per cent, ash 4—8 per cent.

The oil is the part which concerns us most. The maximum oil content is 57 per cent. With modern presses 50 per cent can be extracted. No other oleaginous plant can compete with sesamum in this regard. There are, however, great variations ; certain varieties contain only 35 per cent of fat. An analysis carried out by Broosma in Java in 1904 showed very low percentages, only 39—41 per cent, while Van Rossem in analysing decorticated seed in 1927 found 50.8 per cent for a variety with a thin seed coat and 56.3 per cent for a variety with a thick seed coat.

(2) *Oil.*—Sesamum oil, called also til or gingelly oil, is used as an edible oil in the producing countries and in Europe. It is used also to adulterate olive oil, but such blends can be easily detected owing to the characteristic reactions of sesamum oil. In Germany the addition of 10 per cent of sesamum oil to margarine is prescribed by law because in this way margarine can always be recognized as such.

Indians and Negroes have from remote times used the oil for anointing their bodies and hair. The fact that sesamum oil has no flavour of its own facilitates the addition of perfumes. One pound of the flowers

whose perfume is desired is added to 3 litres of oil and the whole exposed to the sun for 40 days in a closed bottle.

In the European perfumery industry jasmine and citrus flower perfumes are extracted with sesamum oil; 1 kg. of flowers is added to 6 litres of oil and left for 40 hours. The combined cultivation of citrus orchards and sesamum is thus recommendable.

The inferior quality oil is used in soap manufacture and for cooking. As it does not become rancid it can be used as a lubricant. As an illuminating oil it gives an excellent, even, vivid light, but burns rapidly.

In India and China it has a number of medicinal uses. It is used for dressing wounds, for intestinal disorders and for the preparation of a number of medicaments.

The freshly obtained oil has always a somewhat strong odour, but this disappears with time. According to Eberhardt the oil has the following physical and chemical properties :—

Specific gravity at 15°C.=0.923 ; that of oil extracted by heat= 0.924 ; that of sesamum oil from the Levant=0.9265.

" According to Leone and Longi the refractive index is 1.4902 at 10° and 1.4854 at 23°. The specific gravity of the fatty acids=0.9085—0.9095. The fatty acids solidify at 32—34° and, according to Benedikt, melt at 26°. Saponification of 100 gm. of fatty acid requires 19.93 gm. of caustic potash. Solidification of the fatty acids takes place at about 22°, their saturation point is about 17.7°C. Solubility in absolute alcohol=41 per cent. Dextrorotatory.

" Sesamum oil is made up of glycerides of the following fatty acids : solid (12–20 per cent), palmitic and stearic acids ; liquid (88-80 per cent) oleic and linoleic acids.

" In addition to the principal constituents the presence of a small quantity (less than 1 per cent) of non-saponifiable fats has been determined, amongst which are *phytosterine*, an alcohol specific to sesamum oil, and *sesamine*, a body with undetermined function, also specific to sesamum oil.

"At 4°C. sesamum oil appears still perfectly liquid ; it solidifies only at 5°C. into a yellowish white translucid mass resembling the consistency of palm oil, to which it is very similar ; it is, however, free from any granular deposit.

" Heated to 100° sesamum oil begins to boil noticeably. At 150° it begins to change colour and becomes steadily paler until at 215° it gives off a white vapour. As it cools it regains its natural colour. From 300° the oil becomes gradually darker until it is a deep brown. When cooled

it shows, like glycerine, if viewed in oblique light, a very distinct green translucence (Fritsch).

"Sesamum oil agitated with ether gives a white emulsion. After a short time the two liquids separate but the oil is found to be almost entirely bleached."

The great facility with which sesamum oil gives intense colour reactions may be used as a rapid method of verifying its purity and of detecting traces of this oil in blends. The various processes of Baudoin, Camion, Bellier, Cailletet, Soltein, Behrens and Tocher are described in the works of Eberhardt and Von Sprecher.

(3) *Oilcake.*—The cake is made into flat squares weighing about 6 kg. Analysis shows it to have the following mean composition, though liable to variation according to its place of origin :—Water 11 per cent, fat 12.8 per cent, protein 37.2 per cent, carbohydrates 20.5 per cent, cellulose 7.5 per cent, ash 10.9 per cent.

Sesamum cake is readily recognized under the microscope owing to the almost constant presence in most of the cells of the outer integument of a large crystal of calcium oxalate in rosette form.

(4) *Leaves.*—In tropical Africa the leaves of various species (*S. angustifolium*, *S. radiatum*, etc.), are steeped in water and then pressed; the juice thus obtained is gelatinous and serves as an adhesive substance. It is also used against the biting of the tsetse fly.

In the United States the leaves are also thought to possess medicinal properties. The mucilage obtained from leaves steeped in water is used in the Southern States as a beverage in cases of affections requiring an emollient.

In Java also the natives know the medicinal properties of sesamum leaves.

Production in the Various Countries. Trade.—The available data are very incomplete, partly because in many countries sesamum is grown as a secondary crop, and partly because the figures for the most important producing country, China, are incomplete. This should be borne in mind in consulting the following statistics :—

For the area under sesamum a single example is given, which suffices to show the low value of the figures. The example reproduced in Table I is taken from De Tyssonsk.

TABLE I.

Acreage under Sesamum in Java and Madura.

(*in Hectares*)

Year	1921	1922	1923	1924	1925	1926	1927	1928	1929
Acreage	1,410	5,174	1,500	7,511	9,425	14,040	13,911	15,581	16,044

The area cultivated in 1929 would thus be more than 10 times greater than that in 1921. The writer himself criticizes the figures which must result from incomplete data.

Table II, which is taken from the *International Year Book of Agricultural Statistics*, gives an idea of the world production of sesamum.

TABLE II.

World Production of Sesamum in 1930.

EUROPE.		AFRICA.	
Bulgaria	29,640	French West Africa[5] ..	....
Greece	74,437	French Equatorial Africa[6]	....
U.S.S.R.[1]	....	Angola[7] ..	....
AMERICA.		Belgian Congo[8] ..	....
Mexico	66,247	Egypt	48,414
ASIA.		Eritrea	250
China[2]	1,162,667	Kenya	11,491
Cyprus	4,942	Mozambique[9] ..	....
Korea	41,051	Nigeria	97,012
Formosa	10,845	Sierra Leone[10] ..	....
British India	5,314,000	Italian Somaliland ..	16,800
Dutch East Indies ..	50,249	Anglo-Egyptian Sudan ..	456,976
Indo-China	16,618	Tanganyika	31,650
Japan[3]	....		
Kouan Toung	313		
Palestine	223,650	TOTAL ..	7,962,791
Siam[4]	....		
Syria and Lebanon ..	17,870		
Turkey (in Europe and Asia)	287,679		

The approximate estimate of the world production at 8 million quintals is somewhat low. The most important producing countries are British India, China and the Anglo-Egyptian Sudan.

British India.—Area cultivated: 2,089,000 hectares. Production: 4,746,000 quintals (average from 1920-21 to 1928-29). A yield of 2.27 qx. per ha. may thus be calculated. The acreage of secondary sesamum crops is relatively low: 324,000 hectares. The area has not increased greatly of recent years. Exportation, which before the war reached about 25 per cent of the total production, has considerably diminished; in 1925 it represented no more than 5 per cent of the production.

China.—The cultivation of sesamum is widespread. The main centre is the valley of the Yang-Tse-Kiang. The seed is used to some extent for consumption but by far the greater part is used for oil extraction. Three sorts of seed may be distinguished, white, yellow and black. The chief markets are Hankeou and Shanghai. The best product comes from the province of Kiang Si; that from Tse Chouan is of inferior quality.

[1] In 1928: 115,000 qx. [2] Export figures. [3] In 1929: 31,241 qx. [4] In 1929: 11,500 qx. [5] In 1927: 9,700 qx. [6] In 1928: 45,000 qx. [7] In 1929 4,947 qx. [8] In 1929: 112,625 qx. [9] In 1928: 2,571 qx. [10] Exports in 1929: 1,819 qx.

De Tyssonsk, who had at his disposal recent figures, estimates the acreage under sesamum at 730,000 ha. and the total production at 2 million quintals. These figures are not complete as they do not include the large output of the province of Shansi. Annual exports vary between 300,000 and 600,000 quintals. The greatest purchaser is Japan.

The steady increase in sesamum cultivation and trade dates only from the beginning of this century. The increased acreage under sesamum is partly due to the diminution in the growing of the poppy. The favourable prices of the years previous to 1929 encouraged Chinese peasants to take up sesamum growing.

Anglo-Egyptian Sudan.—The cultivation of sesamum and its yields have increased considerably of recent years, as is shown in Table III.

TABLE III.

Cultivation and Production of Sesamum in the Anglo-Egyptian Sudan.

	1927	1928	1929	1930
Acreage in hectares ..	37,549	39,510	81,547	84,643
Production in quintals ..	202,723	213,308	440,261	456,976

The centres of production are in the provinces of the Nuba Mountains, Fung, Cordofan, Kasala and the White Nile. A great part of the crop is exported, mainly to Egypt.

Trade.—Tables IV and V show the surplus exports and imports of sesamum seed.

TABLE IV.

Surplus Quantity of Imports and Exports of Sesamum Seed from the Different Continents.

(*in Quintals*)

	Exporting Continents		Importing Continents.
	Asia.	Africa.	Europe including U.S.S.R.
Average 1909-1913	2,603,000	32,000	2,496,000
,, 1927	301,000	123,000	329,000
,, 1928	610,000	130,000	583,000
,, 1929	866,000	187,000	912,000
,, 1930	950,000	171,000	986,000

The countries mentioned in Table V are the most important importers of sesamum seed.

TABLE V.

Surplus Quantity of Imports of Sesamum Seed in Various Countries.

(*in Quintals*)

	Average 1909-1913	1927	1928	1929	1930
Germany	10,72,658	48,131	87,184	137,934	358,227
Denmark	47,195	60,288	97,443	106,423	66,223
France	571,509	44,586	66,119	37,592	28,763
Great Britain and Northern Ireland ..	..	2,001	5,467	94,628	74,690
Italy	320,788	31,121	122,690	158,125	257,571
The Netherlands ..	..	81,670	135,150	169,820	97,080
Roumania	13,201	18,346	..	20,177	21,702
Jugoslavia	243	13,024	17,841	57,820	67,141
Japan	52,396	174,845	209,923	199,406	235,373
Malaya	5,522	25,005	31,223	32,666	32,484
Korea	2,710	24,958	39,529	38,747	41,467
Egypt	38,277	103,270	83,726	123,129	126,481
Italian Somaliland ..	..	9,204	18,207	13,753	18,536

It is apparent that the greatest pre-war importers, Germany, France and Italy, are no longer reaching the figures of the 1909-1913 period. Importation into Germany and Italy has increased since 1928, while into France it has steadily decreased. As countries newly acquiring prominence as importers of sesamum may be mentioned Egypt and Japan.

Tables VI and VII show the principal countries exporting and importing sesamum oil.

TABLE VI.

Surplus Quantity of Exports of Sesamum Oil.

(*in Quintals*)

	Average 1909-1913	1927	1928	1929	1930
Germany	*	1,077	6,085	15,489	33,862
France	119,404	23,414	24,044	23,286	1,330
Great Britain and Northern Ireland ..	..	—10	640	42,023	18,218
The Netherlands ..	—5,894	30,150	54,750	82,930	34,680
China	8,087	1,334	1,629	1,606	1,500
British India	7,853	3,338	6,804	7,401	6,311
Kenya	152	536	896	1,459	1,339

*The figures previous to 1926 are not comparable as they include groundnut oil. The *minus* sign indicates surplus imports.

TABLE VII.

Surplus Quantity of Imports of Sesamum Oil.

(*in Quintals*)

	Average 1909-1913	1927	1928	1929	1930
Denmark	12,132	344	—6,772	—12,834	1,393
Poland	..	112,732	122,832	189,371	135,842
Sweden	17,120	231	228	276	4,021
United States	..	7,730	28,299	97,919	49,335
Turkey	7,604	20,120	26,930	25,056	133

The *minus* sign indicates surplus exports.

The prices have become lower since 1927. De Tyssonsk quotes the following mean prices for Java from figures given in the *Handels Vereeniging* of Soerabaja.

TABLE VIII.

Average Trade Prices in Florins per Quintal at Soerabaja.

	Seed	
	White	Black
1925	23.7	23.7
1926	24.1	20.8
1927	24.4	19.9
1928	22.2	19.0
1929	18.4	16.9
1930 (January-October) ..	12.9	12.1

Since this time the prices have become steadily lower. The figures given in Table IX are taken from the German periodical *Der Tropenpflanzer*.

TABLE IX.

Prices for Sesamum Seed in Pounds Sterling per ton c.i.f. (Hamburg-Holland).

	Seed	
	White	Varying colours
	£ s.	£ s.
17th January, 1930	16 10	15 15
17th December, 1930	11 15	10 15
17th March, 1931	13 10	12 10
17th July, 1931	13 0	12 0
17th October, 1931	14 0	12 5
14th January, 1932	15 0	13 15

M. Bouchet, French Commercial Attache in Belgium, wrote in July 1931 as follows :—

"Sesamum seed oils, which were formerly much used, are finding their markets disappearing one after the other. They are scarcely or not at all used any longer in the margarine industry. The Near East alone continues buying in small quantities.

"It is generally expected that extraction of sesamum seed will be partially abandoned in the near future for lack of demand for the oils."

General Conclusions.—Although the present situation in the sesamum industry is not favourable it would appear that there is still a future for the crop in tropical and sub-tropical countries. The French and Italian writers cited desire to see an extension of sesamum cultivation, the former in Indo-China to supply France, and the latter in Southern Italy. Von Sprecher considers that there may be prospects for sesamum in Brazil and Northern Argentina, particularly if grown in association with citrus orchards for the preparation of fine perfumes.

It will be necessary to keep two purposes in view, namely, to promote the use of sesamum oil, which in view of its excellent qualities could certainly find a number of additional uses, and to improve crops by the choice of soils which in physical and chemical composition are favourable for sesamum growing and by varietal selection.—W. Bally. *The International Review of Agriculture*, Year XXIII, No. 4.

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